Minnesota Department of Public Safety

Public Safety Wireless Data Network Requirements Project

Commercial Data Networks Assessment Report

Phase 1-Task 6/Deliverable 4

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1 EXECUTIVE SUMMARY

This cellular carrier assessment report is delivered in support of the State of Minnesota Public Safety Wireless Data Network Requirement Project. The purpose of the assessment is to convey the potential ability of the commercial wireless carrier networks to meet the broadband wireless data requirements of public safety users within the State. This report includes direct feedback from the commercial carriers as well as their public statements and reports.

The commercial carriers are natural strategic partners to provide public safety broadband services, or to complement a State owned and operated network. They already serve much of the state with second generation (2G) and third generation (3G) coverage and offer a wide variety of subscriber devices to satisfy many of the form factors desired by public safety. Yet, according to the Needs Assessment report conducted over the course of this project, the commercial carriers do not meet the requirements of all users in important ways. Specifically, users reported that the carriers do not provide adequate statewide coverage and the carrier networks are frequently congested when needed the most. This document explores these and other perceived shortfalls.

The assessment determined that the commercial carriers are experiencing tremendous growth in wireless data services that is being fueled by the large scale adoption and spread of smartphones in the marketplace. This growth is increasing network usage and increases the risk for greater congestion on commercial networks that would ultimately limit data resources available to the State's public safety personnel. The data growth has forced the carriers to seek consolidation, obtain additional spectrum and to deploy new, more spectrally efficient technologies, such as the fourth generation (4G) standard Long Term Evolution (LTE). As LTE is the official standard for public safety broadband services, this report includes the two wireless carriers who have announced LTE deployments in Minnesota – Verizon which now operates LTE (4G) network in the Twin Cities metro area, and AT&T which plans to debut its LTE network in the Twin Cities area by the end of 2012.

The service areas of the commercial wireless carriers do not meet the requirements of the public safety personnel. Although public safety users indicate that the coverage in the Twin Cities metro areas is good, this assessment illustrates that the carriers do not provide service to many rural areas within the State. Even with the legacy and slower 2G service, the carriers do not presently cover 95 percent of the State's geographic area. Both AT&T and Verizon have expansion plans to extend coverage by adding 3G and 4G services to existing cell towers as well as plans to construct new sites. Yet, neither carrier is willing to commit to meeting the ARMER network requirement of 95 percent coverage on a county-by-county basis.

A key requirement for public safety in a wireless data network is priority over other users. The carriers are committed to provide the full scope of priority features found within the LTE standards over a private public safety network using public safety's 700 MHz radio spectrum. However, the carriers would not commit to providing priority to public safety users over their commercial networks, including the ability of public safety users to preempt commercial traffic during emergencies. Without such features, public safety would be at risk because equal priority commercial users would be granted resources while public safety traffic is queued.

The Wireless Data Needs Assessment identified that unrestricted access to a highly reliable and available network to be a fundamental service requirement. Unlike public safety operators, the commercial carriers do not incorporate redundant systems and infrastructure at every site, including generators and

alternate path backhaul. Although the carriers operate highly reliable system backbones, there are vulnerabilities at the individual cell sites where single points of failure exist. One carrier interviewed estimated 99.5 percent availability on their commercial network, whereas the users report needing 99.999 percent availability (especially in the event that the broadband network eventually provides mission critical voice services). The 99.5 percent availability amounts to 43.8 hours of outage per year for commercial networks versus a user requirement of 315 seconds outage per year. The carriers have offered, under a non-disclosure agreement, to provide historical network performance records that would provide a baseline of reliability and availability of the carriers' networks. It is likely, however, that such records would indicate the lower level of availability and would not meet the State's requirements. Many of the carriers' sites do not support generators and redundant backhaul to all carrier sites is deemed cost prohibitive to achieve the commercial business case. Therefore, it is doubtful that the carrier networks would fully meet the State's public safety mission critical broadband requirements regarding network reliability. A definitive answer would be captured in a State procurement.

The carriers were supportive of various public-private partnership opportunities with the State. The opportunities include hosted LTE core equipment (i.e., central switching), a hosted subscriber provisioning system, and other shared infrastructure (e.g., backhaul infrastructure as well as cell site locations) for the purpose of offering private public safety service. In addition, the carriers were open to partnership opportunities that would extend their coverage in currently unserved areas and in providing roaming services outside of the State.

The carriers expressed a willingness to assist public safety in securing enhanced subscriber devices. The User Needs Assessment found that Minnesota public safety personnel desired many of the same devices currently offered by the carriers. The LTE devices currently in the marketplace support the carrier's RF spectral bands but not the portion of 700 MHz spectrum that was allocated to public safety. The carriers are willing to work with the device community to provide the greatest number of device options to public safety. The roaming capabilities of planned LTE devices would be limited to only one carrier's network. In other words, although roaming between the private public safety network and a commercial carrier is possible, the planned devices would not be capable of roaming to their competitor's LTE network. Therefore, a mutual aid subscriber from another state may not be able to access a (potential) prioritized service delivered over the State's commercial providers network while in Minnesota if they subscribe to the competitors roaming service. It is likely that this issue will remain unresolved unless the Federal Communications Commission intercedes.

In summary, the commercial carrier networks do not meet several critical State requirements for wireless data service and there is a substantial risk that their networks may not meet these requirements in the near future. Therefore, Televate recommends against assuming that the commercial carriers' networks alone can meet the State's wireless broadband service requirements. The carriers are positioning themselves to support public safety grade services using a hosted core model (whereby their commercial cores are segregated from public safety cores), shared cell sites, and roaming services. The State should remain open to greater involvement from the carriers, but such commitment can only be secured with a formal procurement process. Given the risks identified in this assessment, it would be unwise for the State to be completely reliant on the commercial carriers for providing the public safety broadband network. From a funding perspective, the worst case would be a fully private system. Therefore, Televate recommends that the State use the private system model to establish a worst-case network funding scenario. In the event that Federal funding does not materialize, the State may need to modify several of its current public safety requirements. The final business

approach to satisfy the State's public safety data needs would then be resolved via a procurement, depending on available funding and the minimum requirements of the State.

2 BACKGROUND

This document represents Deliverable 4 (Task 6) of Televate's Phase 1 Scope of Work with the State of Minnesota. The objective of this document is to report the ability of the commercial cellular carriers to meet the requirements of the State of Minnesota for providing statewide wireless broadband services to public safety personnel.

The Scope of Work calls for an assessment of commercial carriers that announced Long Term Evolution (LTE) deployment plans in the State of Minnesota, in response to the selection of LTE as the national public safety broadband standard. Currently, of the six commercial cellular carriers in the State of Minnesota (AT&T Wireless, Verizon Wireless, MetroPCS, T-Mobile, Sprint, and US Cellular), only four carriers have made public commitments to rollout LTE: AT&T Wireless, Verizon Wireless, Sprint, and MetroPCS. Of these four carriers, only two (2) have announced plans for the deployment of LTE in Minnesota: AT&T, and Verizon. Sprint has recently stated their objective for a nationwide LTE technology strategy but specifics on the rollout are not publically available. Considering that the LTE rollouts are underway by these two carriers, several potential business models could provide opportunities for a public-private partnership:

- A commercial carrier could provide network services throughout the State using commercial spectrum allocations
- A commercial carrier could provide network services to populated portions of the State and the remainder of the State could be served using the public safety 700 MHz spectrum, or vice versa
- A public safety network could leverage some of the commercial carrier's network assets (e.g., leverage core switching function, cell towers, or other network components)
- A commercial carrier can be used as a national roaming partner to deliver service outside the State, and within the State where a State network did not provide coverage (e.g., inside buildings, or as a backup)

This carrier assessment considers information gathered from the following sources:

- The *Wireless Data Needs Assessment Report* prepared by Televate based on direct feedback from selected regional and local agency public safety stakeholders
- Commercial carrier responses to the Request for Information (RFI) dated 15 January 2010
- Meetings with the commercial carriers held on March 31, 2011
- Correspondences with the commercial carriers
- Public statements by the commercial carriers
- National trends

According to the Wireless Data Needs Assessment[1], no carrier fully meets the needs of state agencies and public safety personnel today. The two most critical shortfalls identified in the Needs Assessment were related to the availability of service. First, public safety personnel reported that significant geographic areas in many State counties remain unserved by the commercial carriers. Second, where commercial wireless services do exist, they are frequently saturated during major events, and are unavailable to public safety users.

Commercial Cellular Growth

The push by the commercial carriers to deploy LTE is driven by consumer demand for wireless data services. In its 2010 annual survey, the CTIA (Cellular Telecommunications Industry Association) reported a 110 percent increase of wireless data traffic nationwide[2]. The impetus behind the new demand for wireless data was the increasing popularity of smartphones, the growth of which was fuelled by the falling prices of data plans, the greater capabilities of the commercial carrier networks, as well as the availability of many compelling mobile applications. As a result, smartphone purchases have grown consistently by an average of 35 percent per annum since Q3 2008. It is expected that sometime between Q3 and Q4 of 2011[3] smartphones will overtake all other wireless devices as the dominate device type in use by consumers. The growth rate of smartphones has provoked the incredible growth of wireless data traffic. During their annual survey in 2009, the Nielson Company found that the average smartphone user consumed 300 MB (megabytes) of data per month. Nielson's 2010 survey found that the average monthly data usage increased to 582 MB for Google Android users and 492 MB for Apple iOS users. As more users flock to smartphones, and the traffic per user continues to increase, the net capacity needed to support those users increases[4]. AT&T, for example, has stated that data volume has grown 8,000% from 2007 to 2010[5] and that their network cannot sustain the growth via investments alone[6]. Ultimately, the increases in data usage will cause further network congestion on carrier networks, and will certainly make priority service on commercial networks all the more critical.

Meetings with Commercial Carriers

As part of the assessment, separate meetings were held with AT&T Wireless and Verizon Wireless on March 31, 2011. The purpose of the meetings was to understand the carriers' ability to meet the State's requirements as reported in the Wireless Data Needs Assessment. The commercial carriers were provided a detailed agenda and questions in advance of the meeting focused on investigating their commercial offerings. The project team then documented carrier responses to each requirement,

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[1] As per the conclusions of the Incident Analysis contained within: Minnesota Department of Public Safety, *Public Safety Wireless Data Network Requirements Project, Needs Assessment Report, June 2, 2011*

[2] See http://www.ctia.org/media/press/body.cfm/prid/2062

[3] See http://blog.nielsen.com/nielsenwire/consumer/smartphones-to-overtake-feature-phones-in-u-s-by-2011/

[4] See http://blog.nielsen.com/nielsenwire/consumer/android-leads-u-s-in-smartphone-market-share-and-data-usage/

[5] See http://www.att.com/gen/press-room?pid=19743&cdvn=news&newsarticleid=31838&mapcode=financial

[6] See http://www.att.com/gen/press-room?pid=20019&cdvn=news&newsarticleid=32009&mapcode=corporate|financial

prepared summaries of the responses, and circulated the summaries to key participants. The responses were clarified with the carriers where necessary. Prior to the meetings, the carriers advised the team that some of the requested information was sensitive and required a non-disclosure agreement (NDA). Hence, the information contained herein is limited to non-sensitive information provided by the carriers and publicly available information.

Given this limitation, this document provides a high-level assessment on the ability of the commercial carriers to meet the public safety requirements of the State and outlines specific issues that will need to be addressed under the guise of a formal procurement.

3 Network Operations Requirements

Although not part of existing commercial wireless services contracts, a future public-private partnership between the State of Minnesota and a commercial carrier would require a Service Level Agreement (SLA) as a basis of expectation for service quality. The State indicates its desire to include, at a minimum, the following items within a binding SLA:

- Network Reliability and Availability Objectives
- Communications Procedures, Notifications and Alerts for:
  - Real-Time Traffic and Network Congestion
  - Outages
  - Planned maintenance
- Priority Access
- Supplemental Coverage for Emergency Response

The commercial carriers were supportive of establishing a mutually agreeable SLA, but were unable to make commitments on particular content of the SLA in the carrier meetings.

3.1 Network Reliability and Availability

The end-to-end reliability and availability of the network is a high priority to public safety. The public safety users stipulate a requirement of 99.999 percent for network availability. Network availability is the measurement of the combined reliability of all network elements end-to-end; it includes unavailability due to potential outages caused by equipment failure, loss of backhaul, power failure, and other supporting system failures.

Commercial networks have limited redundancies which makes them more vulnerable to outages. Although, some cell sites have redundant backhaul paths, it is likely that most do not. One commercial carrier estimated that 90 percent of their existing wireless transceiver sites have either generators or battery backup, but they did not provide detail regarding the which sites are equipped with generators or batteries, the minimum battery run time (hours), or the amount of fuel.

Furthermore, the commercial carriers did not make ongoing end-to-end reliability calculations on their networks and instead indicated that a good approximation for their network availability is 99.5 percent[7] or better. The commercial carriers are willing to provide more detailed information and their historic outage records for their networks under an NDA. Historical records may be a reasonable indicator of future availability, but, the records will not indicate service level commitments; those would have to be secured as part of a procurement.

3.2 Communications Procedures

The commercial carriers generally provide outage notifications for both planned and unplanned events to their enterprise customers. The experience of public safety personnel in this area has been mostly positive. The notifications have been timely and accurate and carriers typically provide two weeks advance notice. However, the State requires a more seamless and interactive process. Specifically, the State prefers visibility of operational status of the commercial carrier's network and, if possible, for this information to be seamlessly integrated into their Network Operations Center (NOC). The State also requires approvals on the timing of planned outages.

The carriers were concerned about the complexity of the configuration necessary to provide such increased network visibility. They especially voiced concerns about the security of their network elements. However, the carriers were agreeable to the coordination of planned outages and further improvements to procedures already in place.

3.3 Capacity

As the consumer demand for data capacity increases, the potential for service degradation grows for public safety users on commercial networks. The carriers have made it clear to the Federal Communications Commission (FCC) that they cannot keep pace with the growth in consumer demand[8]. As a result, the risk of congestion on the commercial network is likely to increase over time. This situation makes priority access even more critical if public safety wireless data services rely upon the commercial networks.

One LTE feature that would alleviate network congestion is the Guaranteed Bit Rate (GBR) bearer – providing the end-user with guaranteed throughput. The commercial carriers can help to implement this feature on the private public safety network, but cannot commit to providing it on their commercial networks. One commercial carrier states that the ability to provide GBR-based service contracts may depend upon forthcoming network neutrality rules and the national standards for public safety priority access. In either case, agreements covering the expected capacity would need to be specified in a Service Level Agreement.

[7] Reliability rating of 99.5% equates to a cumulative 43.8 hours of outage time per year of operation.

[8] See http://www.technewsworld.com/rsstory/74125.html

3.4 Priority

There are three key features that are capable of managing the priority of LTE public safety users:

- Quality of Service (QoS)
- Preemption
- Dynamic Priority

Quality of Service

The LTE standard allows the network to establish a level of priority for each application by providing more resources to an application with a high QoS setting versus another with a lower setting. The standard provides nine (9) Quality of Service Class Identifier (QCI) levels. The QCI levels act to improve the performance of the application, specifically, by better controlling latency and other network phenomenon. Public safety would need to coordinate QCI levels and Quality of Service features with the commercial carriers to ensure that their applications are given the appropriate priority over the network.

The wireless carriers indicate that QoS will be a standard feature and will be deployed on their LTE commercial networks. At this time it is not possible predict whether public safety will have unique or higher QoS settings than public users of the carriers' commercial networks.

Preemption

The Application Retention Policy (ARP) feature of LTE allows the network to preempt the services of one user or application over another. The objective for public safety is to be able to secure the highest possible priority and have the ability to preempt active users during an emergency.

The carriers were asked if they would allocate the highest ARP levels to public safety to ensure that public safety would be able to preempt all commercial traffic. The carriers indicated that they were not prepared to provide preemption services of commercial traffic at this time. The carriers indicated they would reconsider their position in response to FCC rulemaking.

One carrier expressed some uncertainty regarding future direction of "Net-Neutrality" rulemaking. At this time, the FCC Open Internet (Net-Neutrality) rules do not prohibit priority access on wireless networks. In fact, recent regulatory activity specifically exempts wireless carriers from any Net Neutrality rules, principally on the basis that the business model for mobile internet relies on novel and non-neutral means of accessing the internet[9].

The subject of priority for public safety users is an area of common concern for all stakeholders involved. The FCC has had ongoing discussions about public safety priority on commercial networks with the FCC Public Safety & Homeland Security Bureau[10]. It also has been a topic of discussion by several FCC

[9] See http://transition.fcc.gov/Daily_Releases/Daily_Business/2010/db1223/FCC-10-201A1.pdf

[10] See http://transition.fcc.gov/pshs/techtopics/techtopics22.html

Commissioners[11]. Considering the interest in this matter, there remains a possibility that the FCC may impact this topic.

Dynamic Priority

The State requires to dynamically manage the priority of its users from its NOC in real-time. Dynamic priority provides the ability to change the network priorities of an individual or groups of users on demand in response to emergency communications requirements. This feature would need to be developed by the LTE vendors since it is not a part of the 3GPP specifications. Nevertheless, the carriers indicate that the feature is possible and can be made available to manage the devices on the private public safety network. The carriers would not commit to making this feature available at this time for management of public safety users on the commercial carrier's network.

3.5 Other Network Features

There are several additional features within the existing Release 8 or Releases 9 or 10 that are of interest to public safety:.

- Evolved Multicast Broadcast Multimedia Service
- GPS based location services
- Seamless Handover
- Push-to-Talk

Evolved Multicast Broadcast Multimedia Service

Evolved Multicast Broadcast Multimedia Service or eMBMS provides the ability to multicast multimedia services to multiple users at a reduced impact on network resources. For example, the video broadcasted from any emergency incident may provide multiple users with a single video stream. Another important service likely to be used by public safety over the eMBMS would be push-to-talk voice communications as this too involves a one-to-many transfer of data. Both commercial carriers have the eMBMS feature on their roadmap and both intend to roll out the feature as demand for broadcasted applications grows. However, there is no expressed timeline and it is unclear how public safety will access it to send media streams to the commercial multicast/broadcast servers. The carriers may tightly control these services (such as pay-per-view television) and may not provide the type of dynamic media streaming that public safety needs.

GPS based location services

GPS based location services are currently used by public safety agencies. The LTE network can provide assisted GPS to improve GPS performance as well as network geo-location when GPS is not available. Both carriers indicate they will be rolling out these enhanced services in the future and to providing public safety agencies access to the enhanced location information.

[11] See http://reboot.fcc.gov/commissioners/baker/blog?entryId=747405

Handovers

Most of the business models above require some level of roaming between a commercial carrier network and a private public safety network. Ideally, roaming would occur with session handover without loss of data. The commercial carriers will support handover from the private public safety network to the commercial carrier's network. Handover from the commercial network to the public safety network is more problematic however, and difficult for the carriers to deploy. Moreover, the carriers would not indicate whether they can support in-session handovers. Without the ability to hand back to the public safety network the user would remain on the commercial network until the data session is completed before returning to the public safety network.

Push-To-Talk

It is important to the State that any statewide LTE network supports interoperability with the P25 LMR network. The commercial carriers are open to making the connectivity between LTE and P25; which would require the integration of a P25 gateway. The carriers do not foresee a problem with the development of an acceptable push-to-talk application that would meet the needs of the users. The carriers indicate that there are several third party vendors who have created or are looking to create push-to-talk applications that meet the requirements of public safety for guaranteed low latency transmissions to include talk-group, multi-group and broadcast transmissions.

4 COVERAGE

The Wireless Data Needs Assessment identifies many concerns from the public safety users regarding the lack of ubiquitous commercial cellular coverage throughout the State. In fact, some public safety agencies have been reluctant to rely on commercial wireless service for mission critical applications because the level of coverage was deemed to be too unreliable. As such, the expansion of coverage of the commercial cellular networks is considered a high priority for public safety users. The benchmark the State of Minnesota hopes to obtain is 95 percent coverage for wireless data services on a county-by-county basis. At this time, no commercial cellular carrier provides this level of service. It should be noted, that public safety users suggested during the Needs Assessment that exceptions may be made to the 95 percent countywide coverage requirement in some remote and forested areas; but any exception granted would require agreement from the local public safety agencies.

4.1 Carrier Comparisons

The following section provides an estimation of coverage from the two prospective LTE carriers, AT&T Wireless and Verizon Wireless. The source of information used was the carrier's posted coverage maps found online[12][13]. All forward looking statements with regard to the prospective LTE coverage were

[12] See Verizon coverage at http://www.verizonwireless.com/b2c/CoverageLocatorController

[13] See AT&T coverage at http://www.wireless.att.com/coverageviewer/#?type=data

derived from their public statements. Both carriers are willing to provide more specific data coverage under the confines of a Non-Disclosure Agreement (NDA).

At present, the carriers provide wireless data services in over 80 percent of the state. When considering the faster 3G wireless data service, the carriers provide an estimated 70 percent coverage. Verizon leverages EVDO to provide the 3G wireless data services. AT&T leverages UMTS/HSPA for their 3G wireless data services. In result, there are substantial portions of the state that are covered only by 2G low-speed networks (Verizon: 1xRTT and AT&T: EDGE/GPRS respectively). Today, 4G LTE service is provided only by Verizon Wireless in the Twin Cities area. By 2013, Verizon intends to deploy LTE at all of their 3G sites. AT&T's current public comments indicate a rollout of 4G services in the Twin Cities area by 2012. The expansion of LTE is important because the advanced capabilities of LTE are required for differentiated services; including its more robust priority and preemption mechanisms. The figures below represent the current coverage presented online by the carriers.

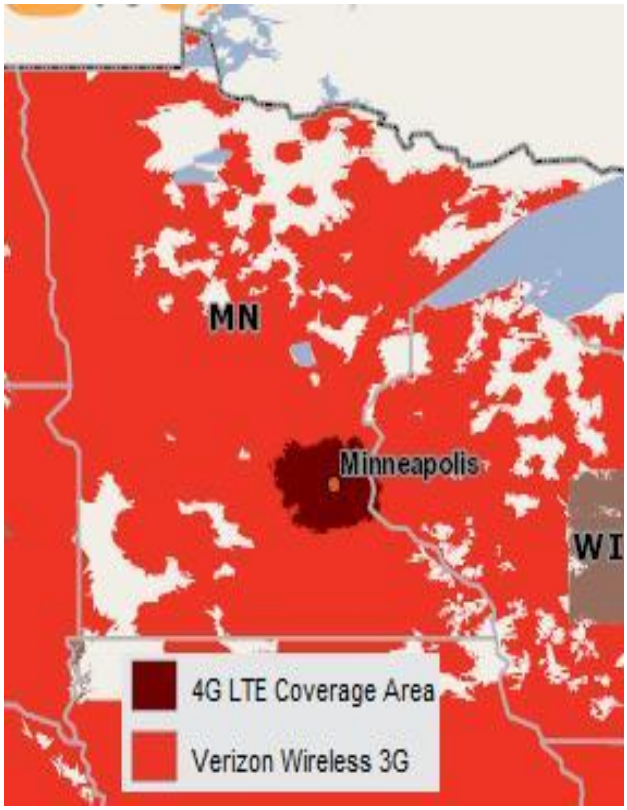

Figure 1 - Verizon Coverage

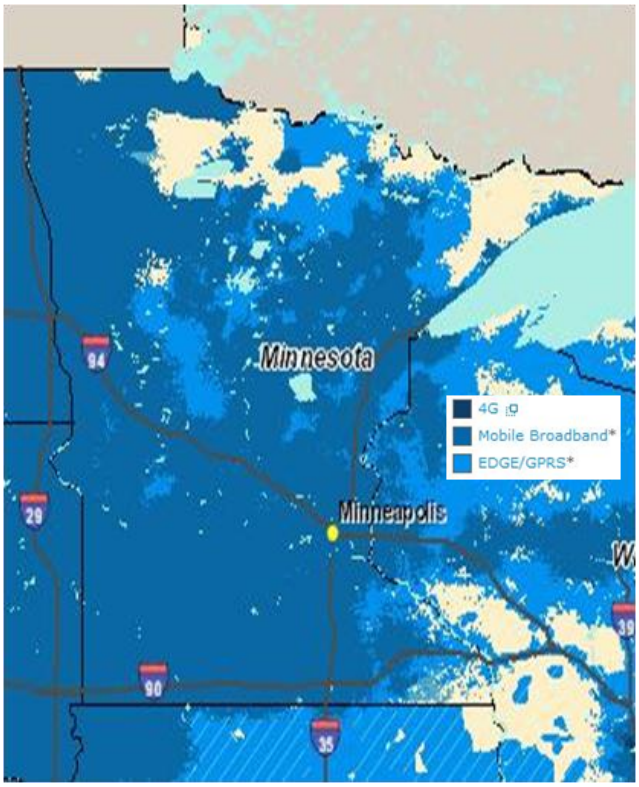

Figure 2 - AT&T Coverage

Although the carriers say they have plans to substantially improve coverage throughout the State and to approach 95 percent coverage statewide, there is no intention to meet the ARMER requirement of 95 percent coverage on a county by county basis. Although both carriers expressed an interest in sharing towers to improve their coverage in remote areas, Televate expects that there would be little incentive for the carriers to cover 95% of each remote county in the State. We suspect that the carriers' business

model would not support the additional equipment, backhaul and maintenance these remote sites would require.

4.2 Supplemental Coverage for Emergencies

Both carriers have emergency response programs to augment their service in the event of a disaster. They can deploy a Cell-on-Wheels (COW), Cell-on-Light Truck (COLT), and even man portable systems if a portion of their network fails or if they need additional coverage. The carriers do not allow the State to control such devices because of FCC licensing issues. This is an important factor because State controlled emergency response systems could dramatically improve the response time of such solutions. In addition to COWs and COLTs, AT&T has recently announced a man-portable supplemental coverage solution referred to as AT&T Remote Mobility Zone (ARMZ)[14]. The unit utilizes satellite data backhaul or any Internet connection to provide localized wireless data services with AT&T's cellular spectrum. Given the carrier's position on the matter, an alternative to meeting emergency coverage requirements may be the use of 700 MHz Band Class 14 COWs, COLTS, and other rapid deployment solutions.

4.3 LTE Relays

Another option for adding supplemental coverage is to use an LTE Relay to boost the signal of the fixed network. The LTE Relay provides the same functionality as an eNodeB, but, capacity is shared with the fixed network. The relay is destined to be an equipment option on LTE Release 10 networks; standardized in March 2011. At this early stage the carriers' cannot determine if or how they would support public safety controlled relays to augment service at an incident.

5 DEVICES

The Wireless Data Needs Assessment identified a diverse range of device types required by the State's public safety personnel. Most are available from commercial carriers. One agency identified the need to deploy Apple iPads to its police officers. Such a device is available on AT&T's 2G and 3G bands, but support of public safety's 700 MHz spectrum (Band Class 14) will require modifications to the chipsets in the device. A decision to support Band Class 14 on the iPad will require a positive return on investment for Apple and its wireless chip maker(s). Because of their buying power, the carriers' requirements can tilt the balance of the return equation for device makers. The total domestic marketplace for public safety devices may be on the order of one to 20 million. This variance is largely due to the definition of public safety users as defined by the FCC and thus the categories of government workers that can use the Band Class 14 spectrum. Still, the public safety market is smaller than the commercial market, which is at 302.9 million subscriber devices and growing[15]. The smaller public safety market presents a risk that the device vendors may not build Band Class 14 devices.

[14] See http://www.wireless.att.com/businesscenter/business-programs/mid-large/remote-mobility-zone.jsp

[15] See http://www.ctia.org/advocacy/research/index.cfm/aid/10323

Both carriers will use the 700 MHz spectrum they have recently purchased at auction; AT&T Wireless will utilize Band Class 17 and Verizon Wireless will utilize Band Class 13. The latter is adjacent to Public Safety's allocated spectrum, Band Class 14 represented in Figure 3 below.

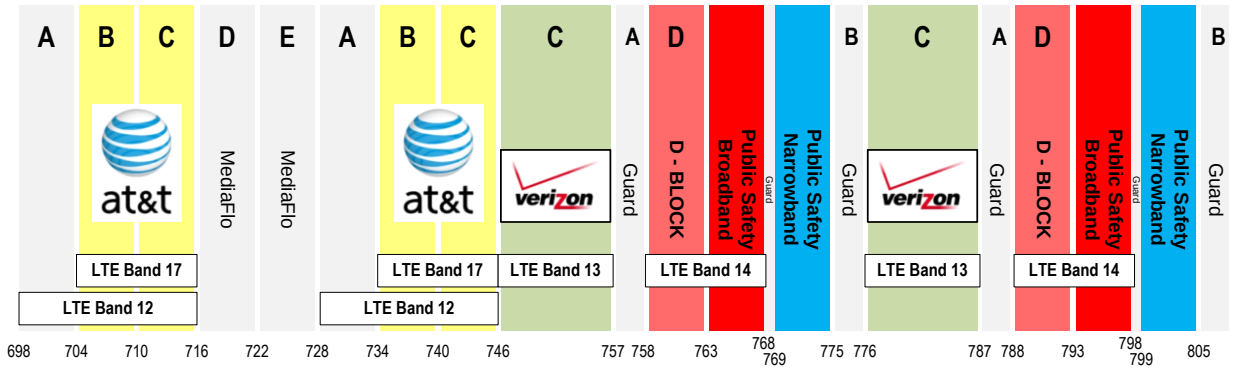

Figure 3 - 700 MHz Spectrum

The commercial carriers indicate that a wide variety of devices will eventually be available to support the 700MHz public safety spectrum (Band Class 14). The carriers are working closely with multiple device vendors to provide Band Class 14 in their commercial devices. The commercial carriers certify all devices that operate on their networks. Both carriers indicated that they would provide a certification program for Band Class 14 devices.

The State requires that the public safety broadband network provide service to incoming mutual aid personnel. This requirement is a unique challenge in conjunction with roaming. If, for example, the State of Wisconsin were to partner with one carrier while Minnesota partners with a different carrier, the devices of both states would have to support both carriers in order for network access to be feasible on the public safety carrier partner network in each State. AT&T and Verizon are both deploying devices that will not operate on each other's LTE networks. Furthermore, the major carriers simply do not allow roaming on each other's networks today. Therefore, a Wisconsin user may not be able to access the differentiated commercial service available in Minnesota[16]. The carriers were unable to commit to allowing competitive roamers access to their networks. It should also be noted that the FCC recently released rules that require the carriers to enable data roaming between carriers "on commercially reasonable terms and conditions[17]." There is no guarantee, however, that the carriers will "come to terms."

Both carriers indicated that their devices would be backward compatible to 3G and 2G networks. The backward compatibility will aid public safety when roaming in areas of poor 4G coverage.

[16] Presuming that Minnesota leverages the commercial service of a carrier and secures various public safety "upgrades" such as priority and enhanced coverage, the Wisconsin user, without access to that network, would be forced to remain on the commercial service of its provider in Minnesota.

[17] See http://transition.fcc.gov/Daily_Releases/Daily_Business/2011/db0407/DOC-305622A1.pdf

6 Business Models / Partnerships

The variations of the business models or partnerships are dependent on the LTE equipment and systems that are shared (leased) and those that are owned, managed and operated by the State of Minnesota. The options can be endless; however, the following models were discussed with the commercial carriers:

- Leveraged Hosted Core Network
  - Shared Core with Carrier
  - Separate Leased or State-Owned Core
- Coverage Enhancements in Unserved Areas
  - Shared Site Infrastructure

6.1 Leverage Hosted Core Network

The Evolved Packet Core (EPC) is the central "switching" component of LTE networks. The shared core model has several advantages that would be attractive to public safety. First is the potential for reduced capital and operational expenses should the State lease/share rather than own/operate the core network. The second advantage would be that an operator's core would be brought up to date with the latest features and releases keeping public safety current with the latest technology. The commercial carriers were hesitant to share the core networks that are used for commercial service. The carriers would prefer that public safety operate their sites from a separate standalone or hosted public safety core network.

6.2 Share Sites

As stated earlier, the carriers currently cover a little more than 80 percent of the State of Minnesota. The lack of ubiquitous coverage in rural areas was one the chief complaints about existing wireless service offerings. Another business model discussed with the carriers was the possibility for the State to concentrate its initial expenditures only on the areas without services and leverage commercial carriers elsewhere. This business model would require the build out of sites where there has been little commercial justification to serve before. The carriers expressed their openness to the goal of increased coverage and their willingness to explore options where costs of deploying new sites in unserved areas can be shared.

It is possible that the cost of towers, backhaul, antenna systems and all infrastructures could be shared. The sharing of the infrastructure can either be accomplished on a quid pro quo basis or by leasing. To some degree, both commercial carriers are open to sharing infrastructure. Specifically, the level of sharing would be subject to a detailed financial agreement.

7 SUMMARY

The following table summarizes of the key user and system requirements of the State and the wireless carrier's ability to meet those requirements. Because the opinions of public safety users varied on the requirements, the most stringent (i.e., most difficult to meet) requirement is listed.

Criteria	Minnesota Requirements (Most Stringent)	Wireless Carriers Feedback
SLA	• SLA for wireless services, reliability, availability	• The carriers are willing to include commercial wireless services in a SLA with the state.
Priority	• Preemption • Highest Priority of Wireless Data on Carrier's Network	• QoS for public safety users on the commercial wireless networks will be considered. • Preemption on the commercial wireless networks is not being considered at this time by carriers. However, it will be supported on the private public safety network
Changes to Priority Settings	• Modify Priority and QoS Settings of Users Real-Time	• Modifications to public safety user priorities (QoS) on commercial network will be considered by the carriers. • The carriers will abide by any future FCC rules governing static QoS
Coverage	• 95% Coverage on County-by-County	• Some counties have considerably less coverage if calculated on a countywide basis. • The carriers will collaborate to extend coverage in remote areas on potentially shared infrastructure. • Verizon has deployed 4G coverage in Twin Cities and intends to deploy 4G at all 3G sites in the state. Verizon's 2G coverage is greater than its 3G coverage. • AT&T plans 4G coverage in Twin Cities 2012. 3G at all remaining MN sites with further expansion of coverage to in 2012
Coverage Extension	• Public Safety Controlled COW, COLT or Relay Extending Radio Coverage	• The carriers can provide COW or COLT; the state can potentially purchase these items as well. A further man-portable option with satellite backhaul is also possible

Criteria	Minnesota Requirements (Most Stringent)	Wireless Carriers Feedback
Reliability	• 99.999% Reliability on all network elements	• Backbone: the carriers indicate they have extremely high reliability backbones and cores • Base stations with generator or battery where possible ~90% with generator or battery • Can provide outages under NDA • Not expected to have substantial number of redundant backhaul
Roaming	• Bi-directional Handover from Carrier's to Public Safety's Network	• Carriers plan to support handover from the public safety network to commercial network; however, there was not a firm commitment for active session handover from their networks back to the public safety network
Capacity	• GBR for Public Safety Service on Carrier's Network	• The carriers can provide GBR on private public safety network; dependent upon LTE Release 10
Devices	• Band Class 14 Devices needed including USB and embedded modems, tablets, smartphones,	• The carriers and their partners are working on Band Class 14 devices with roaming capabilities to their networks including smartphones, USB, and vehicular modems • Carriers are committed to bring additional manufacturers of Band Class 14 devices to market
Mutual Aid	• Commercial network must be able to support incoming roamers	• No devices are foreseen that will contain all 700 MHz band classes • No commitment to support roaming from other carriers at this time
Peer-to-Peer	• Peer-to-Peer Functionality for Public Safety LTE Devices	• Dependent on device • Needs to be answered by device community

The table above illustrates that the carriers have a sincere interest in meeting public safety wireless broadband requirements. However, some of the State's requirements may conflict with their respective business objectives. Understanding the full scope of their ability to meet the State's needs is unlikely to be captured within the Requests for Information (RFI) process. Instead, the State would likely need to proceed with a full procurement and to obtain proposals that lead to a contractual obligation to understand the full intention and commitment of the commercial carriers. Televate sees substantial risks in assuming that the carriers will meet the stated requirements of the public safety community. In particular:

- There is a high risk that the carriers will not allow public safety traffic to preempt commercial traffic. Additionally, the carriers may not allow extensive use of Guaranteed Bit Rate (GBR)

bearers on their networks. Therefore, the growing commercial data traffic may continue to saturate carrier networks in emergencies and reduce the capacity available for public safety. It may be possible, however, to attain pre-emption or priority for a limited amount of the carrier's resources. In other words, as long as public safety does not absorb all or most of the carrier's capacity, they may be willing to provide "guaranteed", but also limited, resources. Televate is unsure if the carrier networks can limit the preemption or if this is agreeable to the State.

- There is a high risk that the carriers will not require their vendors to build devices that support roaming from competitors, nor will they allow some competitors' subscribers onto their network. Therefore, mutual aid roamers coming in to Minnesota may not be able to access whatever differentiated services (priority, coverage, etc.) are available with Minnesota's commercial partner. However, a FCC ruling could require such access. In addition, while the mutual aid providers may not be able to access the Minnesota network, they could use other local commercial networks and interoperability could be feasible via the Internet.
- There is a high risk that the carriers will not commit to 99.999% network availability. The amount of traffic they carry necessitates fiber to many sites. It is extremely expensive to deliver dual path redundancy to reach that availability level. Furthermore, 100% of their cell sites cannot support generator backup. However, Televate suspects that the carriers would be able to provide outdoor coverage to most of their footprint with power and backhaul redundancy as a potential compromise.
- There is a high risk that the carriers will not provide 95% service on a county-by-county basis within the next ten years. However, the State could augment carrier networks using 700 MHz Band Class 14 coverage wherever commercial service does not exist.

Given these risks, the State should not assume that the commercial carriers will fully meet the requirements of the State's public safety users. Consequently, Televate recommends that the State keep its options open and plan for multiple business models. The State should carefully evaluate the requirements that the carriers may not meet and determine where compromise is feasible. Televate envisions a Request For Proposal (RFP) that would allow a private and commercial Radio Access Network (RAN) and a private or hosted core. The available budget (e.g., from Federal grants) may dictate the feasibility of meeting all desired network requirements. Additionally, the federal grant or Commission rules may require that the State provide statewide coverage using Band Class 14 (not only where commercial carriers do not provide service). Therefore, Televate recommends that the State create budgets and plans for a wholly private network as the basis for a Federal funding request. In the event that Federal funds do not materialize, Televate recommends that the State carefully consider its requirements regarding a commercial partner as discussed above and leverage its buying power via a public safety specific RFP to secure some level of differentiated public safety service. The monthly cost for such a differentiated service may be higher to sustain priority access, however, State and local agencies could leverage those services as needed and as their budgets allow.